

CLAIMS

5 1. A de-skew system comprising:

a plurality of data channels over which data is transmitted;

a plurality of selectors coupled to the plurality of data channels; and

10 a controller coupled to the plurality of selectors and configured to cause the selectors to provide data from a desired data channel for transmission over a forward data sample channel.

15 2. The system of claim 1 wherein data transmitted over the forward data sample channel comprises a forward data sample, the forward data sample further including a header.

20 3. The system of claim 2 wherein the header comprises a fixed pattern and at least one channel number.

4. The system of claim 2 wherein the header further comprises sample length and status words.

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5. The system of claim 2 wherein the header precedes the forward data sample.

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6. The system of claim 1 further comprising:

a processor receiving data from the plurality of data channels and the forward data sample channel; and

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a de-skew module configured to collect portions of the received data and to adjust collection of each of the received data based on the received forward data sample and the collected portions of the received data.

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- 5 7. A de-skew system comprising:
 a processor configured to receive input data and generate parallel data;
 a buffer unit receiving the generated parallel data and a clock signal and generating a plurality of data signals based
10 on the received generated data and clock signal; and
 a control unit configured to collect portions of the plurality of data signals and to generate a forward data sample based on the collected portions of the plurality of data signals.
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- 20 8. The system of claim 7 further comprising:
 de-skew units each receiving at least one of the plurality of data signals and adjusting received data based on a timing signal; and
 control unit configured to collect portions of the plurality of data signals and to generate the timing signal based on the forward data sample and the collected portions of the plurality of data signals.
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- 30 9. The system of claim 8 further comprising input drivers receiving the plurality of data signals and the forward data sample and supplying the plurality of data signals to the de-skew units and the forward data sample to the control unit.
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10. The system of claim 9 further comprising a buffer unit receiving data from the de-skew units and a clock signal and generating a plurality of data signals based on the received clock signal.

11. The de-skew system of claim 7 further comprising:
5 a delay unit receiving the forward data sample and
generating a delayed forward data sample delayed by a
predetermined amount of time; and

wherein the control unit receives the delayed forward data
sample and generates the timing signal based on the delayed
10 forward data sample and the collected portions of the plurality
of data signals.

12. A de-skew method comprising:
15 receiving data from a plurality of data channels;
selecting a portion of data from each of the received data
from the plurality of data channels; and
generating a forward data sample comprising the selected
portions of data.

20 13. The de-skew method of claim 12 further comprising
receiving the forward data sample;
identifying the portion of data corresponding to the
received data from the plurality of data channels;
25 determining a delay based on timing between the portion of
data and the corresponding received data; and
passing the received data along the plurality of data
channels after the determined delay.

30 14. A de-skew method comprising:
centering a forward data sample;
comparing the forward data sample to data on one of the
plurality of data channels; and
35 determining a time variation between the data and the
forward data sample when the forward data sample corresponds to

the data.

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15. The method of claim 14 further comprising delaying the forward data sample based on the determined time variation.

10 16. The method of claim 14 wherein centering the forward data sample further comprises:

setting a sampling point of a first data channel; and
sampling the first data channel at the set sampling point.

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17. The method of claim 14 wherein centering the forward data sample further comprises sampling the first data channel at a midpoint of a predetermined de-skew range.

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18. The method of claim 14 wherein centering the forward data sample further comprises sampling the first data channel at approximate a center of a data eye of the first data channel and near a midpoint of a predetermined de-skew range.

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19. A de-skew method comprising:

determining a channel number for a forward data sample;

retrieving data from a data channel identified by the channel number, the data channel being a first data channel;

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comparing the data from the first data channel with a slice of delayed data from the forward data sample; and
adjusting timing of the forward data sample when the data from the first data channel corresponds to the slice of the delayed data.

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20. The method of claim 19 wherein adjusting time of the forward data sample comprises delaying the forward data sample

by an amount of time the slice of delayed data is delayed.

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21. A de-skew method comprising:

selecting data from specific channel of a plurality of channels;

centering skew adjustment for the specific channel;

10 adjusting a forward data sample until data in the forward data sample matches the selected data;

selecting another channel of the plurality of channels;

adjusting skew on the selected channel until data in the selected channel matches the forward data sample; and

15 rotating through all the plurality of channels to select and adjust skew of all the plurality of channels to match the forward data sample.

20 22. The method of claim 21 further comprising:
receiving a header; and
decoding the header to determine a channel number.

25 23. The method of claim 22 wherein the header comprises a fixed pattern and at least one channel number.

24. The method of claim 22 wherein the header further comprises sample length and status words.

30 25. The method of claim 22 wherein the header precedes the forward data sample.

35 26. The method of claim 25 where the forward data sample comprises a fixed quantity of data samples.

27. The method of claim 21 further comprising word
5 aligning data from the plurality of channels.

28. The method of claim 21 further comprising byte
aligning data from the plurality of channels.

10 29. The method of claim 21 wherein centering skew
adjustment further comprises centering a sampling point of the
selected channel.

15 30. The method of claim 21 wherein center skew adjustment
further comprises:

sampling a plurality of points of data from the selected
data channel; and

20 comparing the plurality of sampled points to determine a
center of the data of the selected data channel.

31. A de-skew system comprising:

a processor configured to receive input data and generate
parallel data;

25 a de-skew unit receiving the generated parallel data and
a timing signal and adjusting timing of the generated parallel
data, based on the timing signal, to generate a plurality of
data signals; and

30 a control unit configured to collect portions of the
plurality of data signals and to receive a loop data sample and
generating the timing signal based on a comparison of the
collected portions of the plurality of data signals and the loop
data sample.

35 32. The system of claim 31 further comprising:

5 a buffer unit receiving the plurality of data and a clock signal and generating a plurality of data signals based on the received clock signal; and

10 a reverse control unit configured to collect portions of the plurality of data signals and to generate a loop data sample based on the collected portions of the plurality of data signals.

33. The de-skew system of claim 32 further comprising input drivers receiving input data.

15 34. A de-skew method comprising:

receiving a loop back data sample;

determining a data channel specified by the loop back data sample;

20 determining a delay for data from a specific channel when the determined data channel is the specific channel; and

delaying data from the specific channel by the determined delay.

25 35. The method of claim 34 wherein determining a delay comprises:

providing data from the specific channel to a delay element; and

30 comparing data from the delay element with the data from the loop back data sample.

35 36. The method of claim 35 wherein delaying the specific channel comprises adjusting the delay time of the delay element when the data from the delay element corresponds to the data from the loop back data sample.

5 37. The method of claim 34 further comprising setting the specific channel at a midpoint.

10 38. The method of claim 35 further comprising selecting another channel to supply data to the delay element.

15 39. The method of claim 34 further comprising comparing data from the loop back data sample with the delayed data from the specific channel when the determined data channel is the specific channel.

20 40. The method of claim 39 further comprising selecting another channel based on the comparison of the data from the loop back data sample with the delayed data.

25 41. The method of claim 39 further comprising:
 determining a delay for the specific channel based on the comparison of the data from the loop back data sample with the delayed data; and
 adjusting the delay of the specific channel.

30 42. A method of deskewing parallel data channels between a transmitting unit and a receiving unit using a forward sample channel, the transmitting unit providing data signals to the receiving unit over the parallel data channels and also providing sample signals to the receiving unit over the forward sample channel, the method comprising:

35 selecting a data channel for deskewing;
 transmitting data over the data channel;
 transmitting the data over the forward sample channel;

comparing received data transmitted over the data channel
5 with received data transmitted over the forward sample channel;
and
deskewing the data channel based on the comparison.

43. The method of claim 42 further comprising selecting
10 a further data channel for deskewing;

transmitting further data over the further data channel;
transmitting the further data over the forward sample
channel;

15 comparing received further data transmitted over the
further data channel with received further data transmitted over
the forward sample channel; and

deskewing the further data channel based on the comparison.

20 44. The method of claim 43 further comprising
transmitting a header over the forward data sample.

45. The method of claim 44 wherein the header includes an
indication of the selected channel.

25 46. The method of claim 45 wherein the header is
transmitted over the forward sample channel prior to
transmission of data for a data channel over the forward sample
channel.

30 47. The method of claim 46 where deskewing is
accomplished by adjusting a delay in the path of data received
over the data channels in the receiving unit.

35 48. A method of deskewing parallel data lines comprising:

providing parallel data over a plurality of parallel data
5 lines;

successively providing sample data over a sample channel,
the sample data corresponding to data of the parallel data;
using the sample data to align the parallel data.

10 49. The method of deskewing parallel data lines of claim
48 wherein the parallel data lines provide parallel data from
a first unit to a second unit and the sample channel provides
sample data from the first unit to the second unit.

15 50. The method of deskewing parallel data lines of claim
48 wherein the parallel data lines provide parallel data from
a first unit to a second unit and the sample channel provides
sample data from the second unit to the first unit.

20 51. A system including deskew functions comprising:
an upstream unit providing parallel data to a downstream
unit over parallel data channels;
a downstream unit receiving the parallel data from the
25 upstream unit over the parallel data channels;
a sample channel coupling the upstream unit and the
downstream unit, the sample channel carrying samples of the
parallel data.

30 52. The system including deskew functions of claim 51
wherein the sample channel carries samples of the parallel data
from the upstream unit to the downstream unit.

35 53. The system including deskew functions of claim 51
wherein the upstream unit includes a sampler for placing samples

of data from a selected parallel data line on the sample
5 channel.

54. The system including deskew functions of claim 53
wherein the downstream unit includes a deskew circuitry for each
of the parallel data channels.

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55. The system including deskew functions of claim 54
wherein the downstream unit includes control circuitry providing
adjustments to the deskew circuitry based on a comparison of
15 portions of the parallel data and data provided over the sample
channel.

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56. The system including deskew functions of claim 51
wherein the sample channel carries samples of the parallel data
from the downstream unit to the upstream unit.

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57. The system including deskew functions of claim 56
wherein the downstream unit includes a sampler for placing
samples of data from a selected parallel data line on the sample
channel.

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58. The system including deskew functions of claim 57
wherein the upstream unit includes a deskew circuitry for each
of the parallel data channels.

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59. The system including deskew functions of claim 58
wherein the upstream unit includes control circuitry providing
adjustments to the deskew circuitry based on a comparison of
portions of the parallel data and data provided over the sample
channel.

5 60. A system of two units coupled by parallel data lines comprising:

 a first unit providing parallel data over N parallel data lines;

10 a second unit receiving the parallel data over the N parallel data lines;

15 a spare channel in parallel with the N parallel data lines, the first unit providing data of the parallel data lines over the spare channel, the second unit receiving the data of the parallel data lines over the spare channel;

20 a return channel in parallel with the N parallel data lines, the second unit providing data of the parallel data lines over the return channel, the first unit receiving the data of the parallel data lines over the return channel; and

25 at least one unit in the first unit deskewing the N parallel data lines using data of the parallel data lines received over the return channel.

30 61. The system of two units coupled by parallel data lines of claim 60 wherein the second unit includes a selector for replacing data from a selected one of the N parallel data lines with data from the spare channel.